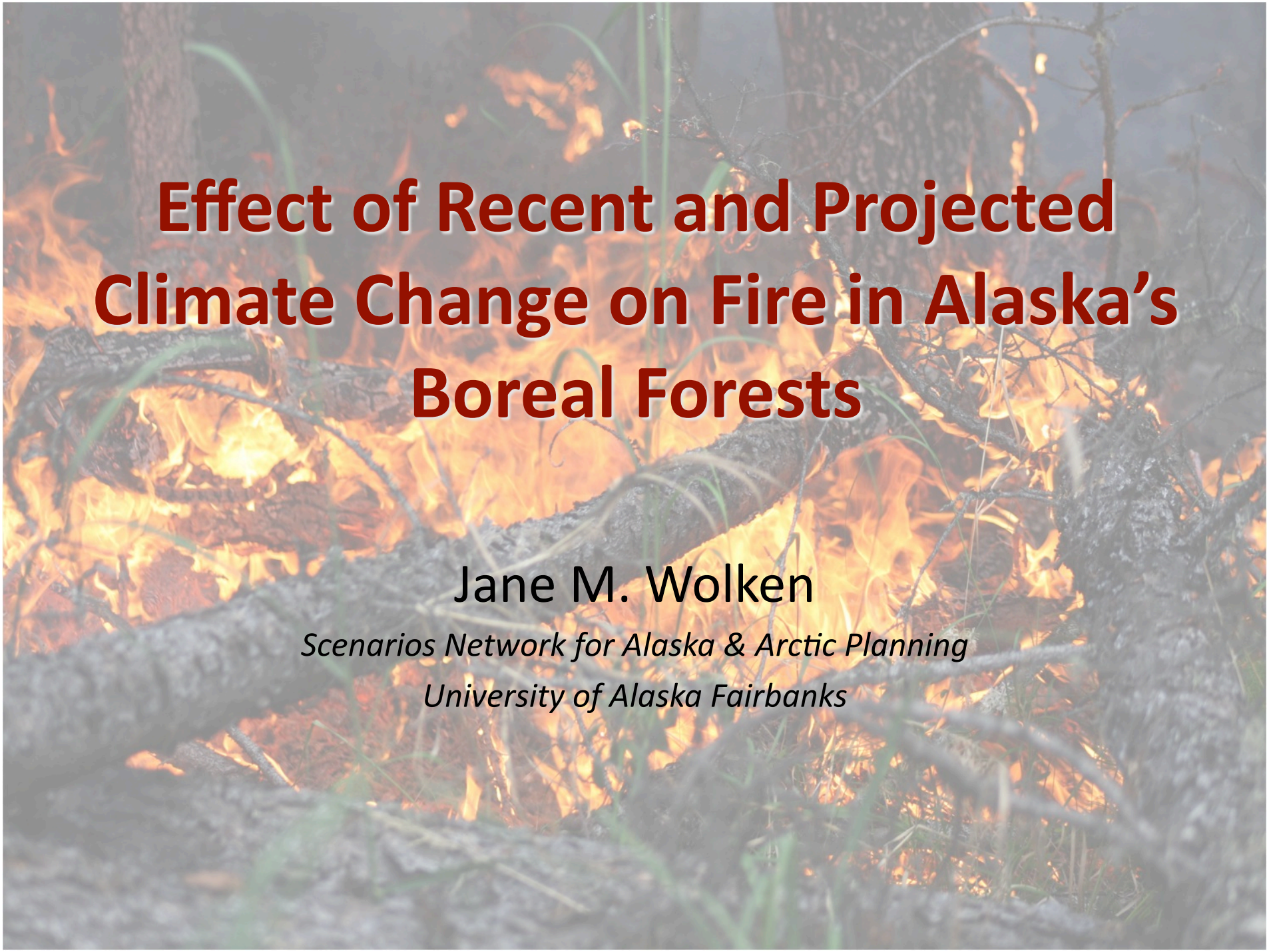

Effect of Recent and Projected Climate Change on Fire in Alaska's Boreal Forests

Jane M. Wolken

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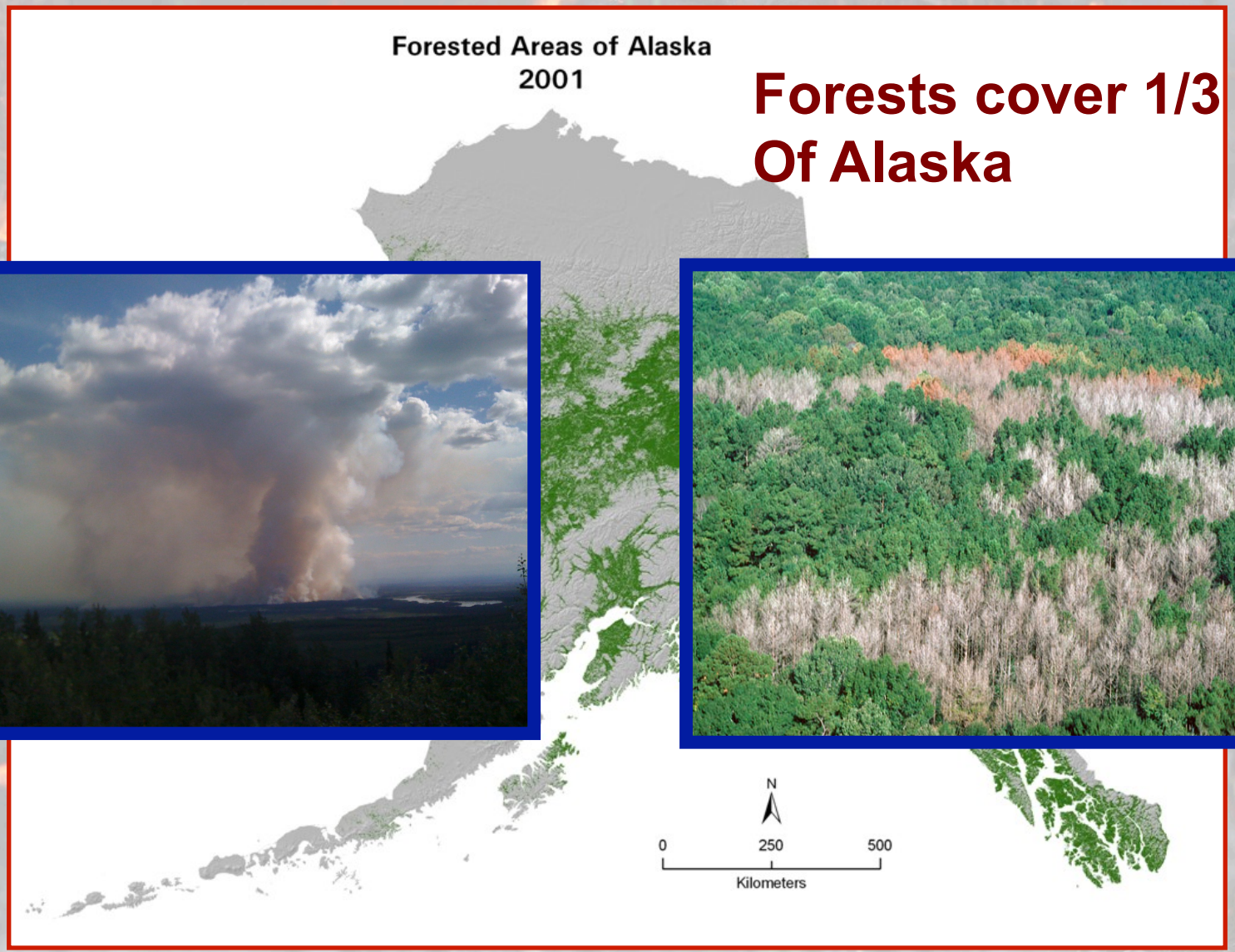
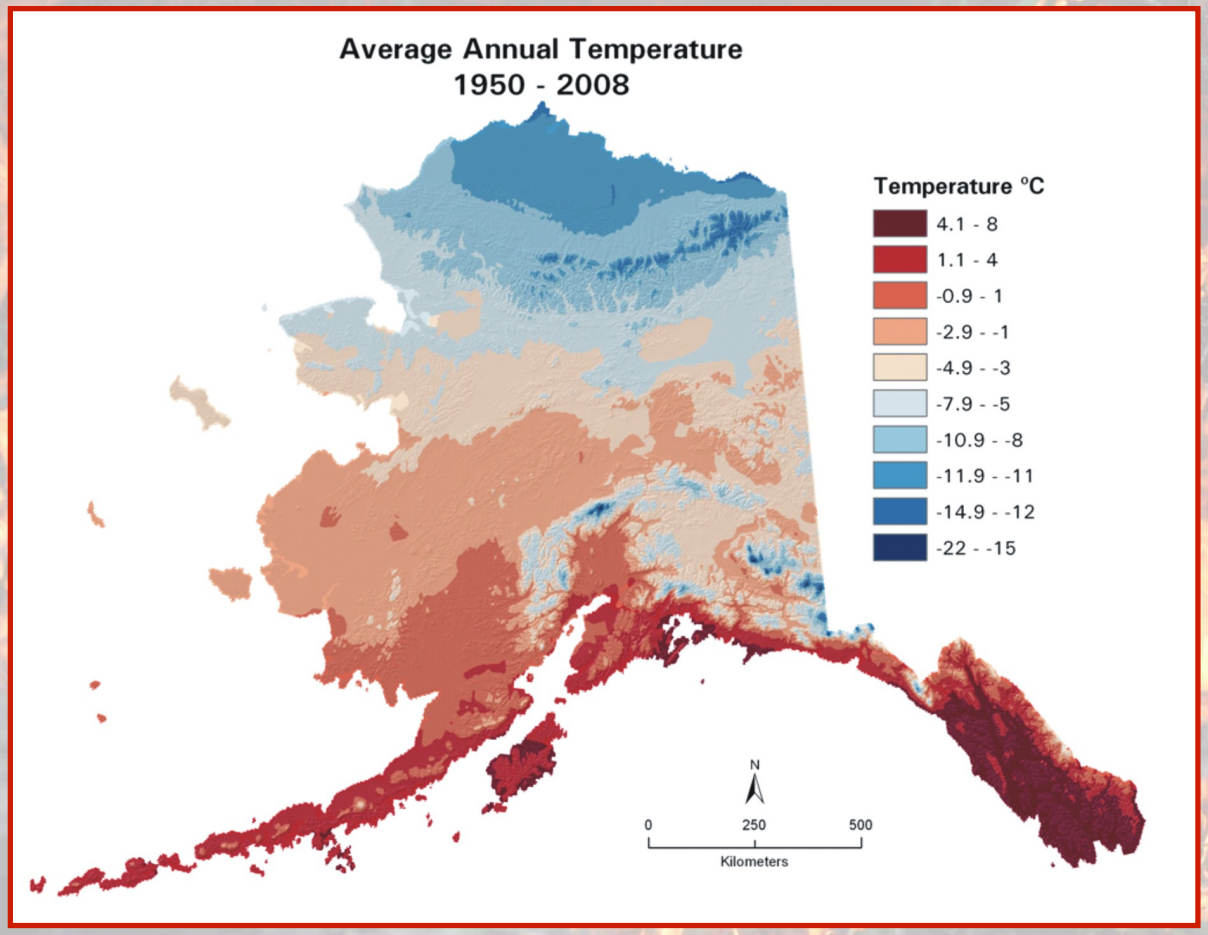
University of Alaska Fairbanks

Alaska's Forests



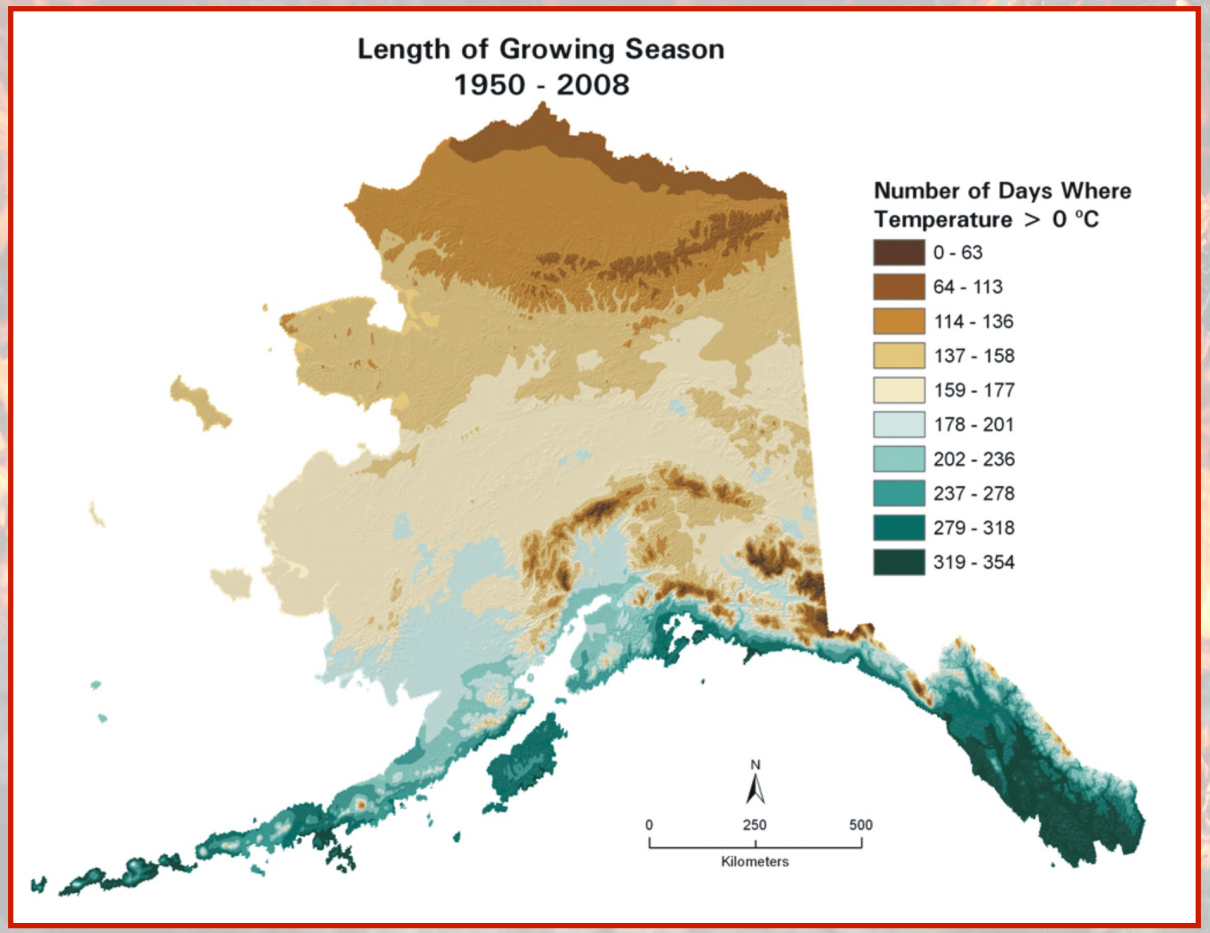
Forests cover 1/3 Of Alaska

Alaska's Climate…



- Mean annual temperature (MAT) in forested Alaska ranges from ~4˚C to -4.9˚C

…Alaska's Climate



- Considerable variation in the length of the growing season throughout Alaska

Climate Change

- Climate related changes have occurred
- During the 20th century, boreal Alaska has warmed twice as fast as the global average
- In Interior Alaska:
  - The MAT has increased by 1.3˚C over the last 50 years
  - Precipitation has increased by only 1.4 mm/decade
- Warming since the 1950s appears to be unprecedented in the last 400 years
  - e.g., Decreased spruce growth in boreal region

Changes in Disturbance Regimes are Linked to Climate

i. Wildfire
   - In the last decade, the annual area burned doubled compared to any decade in the last 40 years

ii. Recent outbreaks of damaging insects (e.g., *Dendroctonus rufipennis* in the Southcentral and Kenai Peninsula of Alaska)

iii. The rate of new introductions of exotic flora taxa has increased from 1 to 3 species/year (1941-1968 and 1968-2006, respectively)

Collaborative Assessment of Climate Change Effects in Alaska's Forests

- In February 2010, university, state and federal scientists met to develop a strategy to assess the impact of climate change on Alaska's forests
- The goals were to:
  1) Develop a conceptual framework;
  2) Summarize the projected changes in key climate variables;
  3) Evaluate the global implications and feedbacks that may alter the rate of changes;
  4) Summarize the regional societal consequences;

Peer-reviewed paper resulting from this collaborative effort

esa

ECOSPHERE

Evidence and implications of recent and projected climate change in Alaska's forest ecosystems

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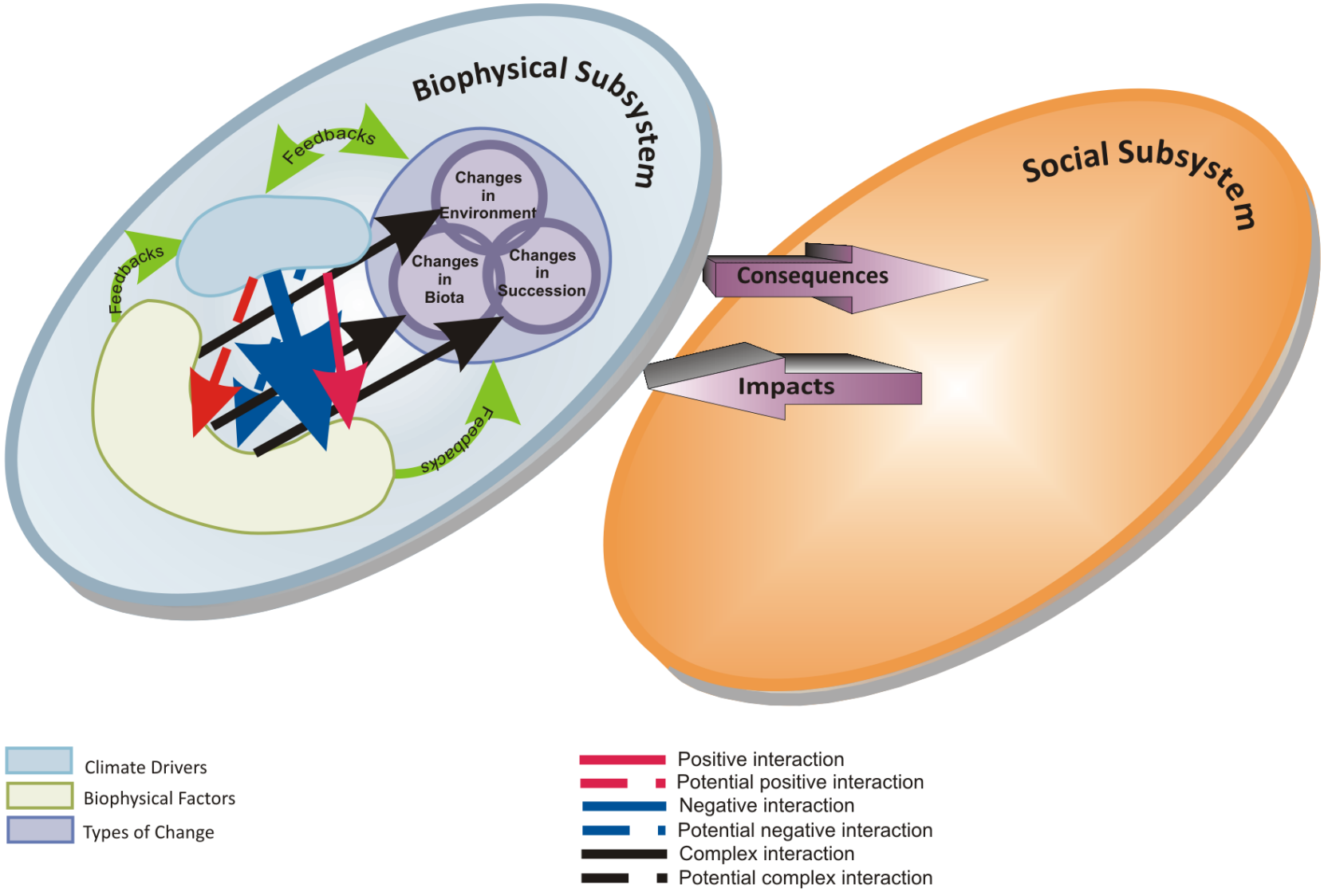
The Conceptual Framework



The Process…

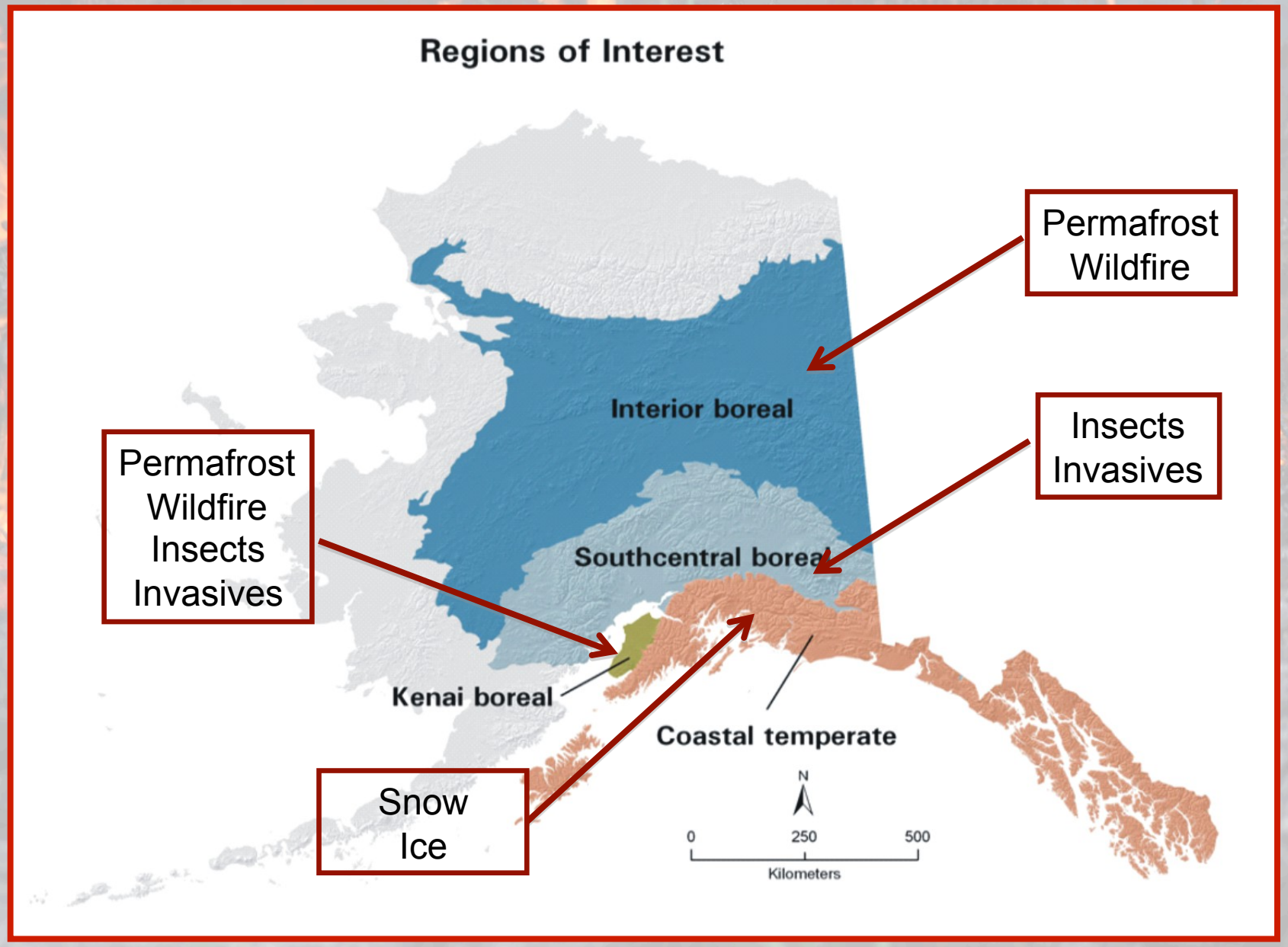
We identified the primary *climate drivers, biophysical factors* and *types of change*

Climate Drivers
= the climate variables (e.g., wind, surface air temperature, precipitation) that directly/ indirectly affect the biophysical subsystem

Biophysical Factors
= the primary categories of disturbances and surface characteristics (e.g., insects, disease, invasive species, permafrost, wildfire) that change in response to the climate drivers

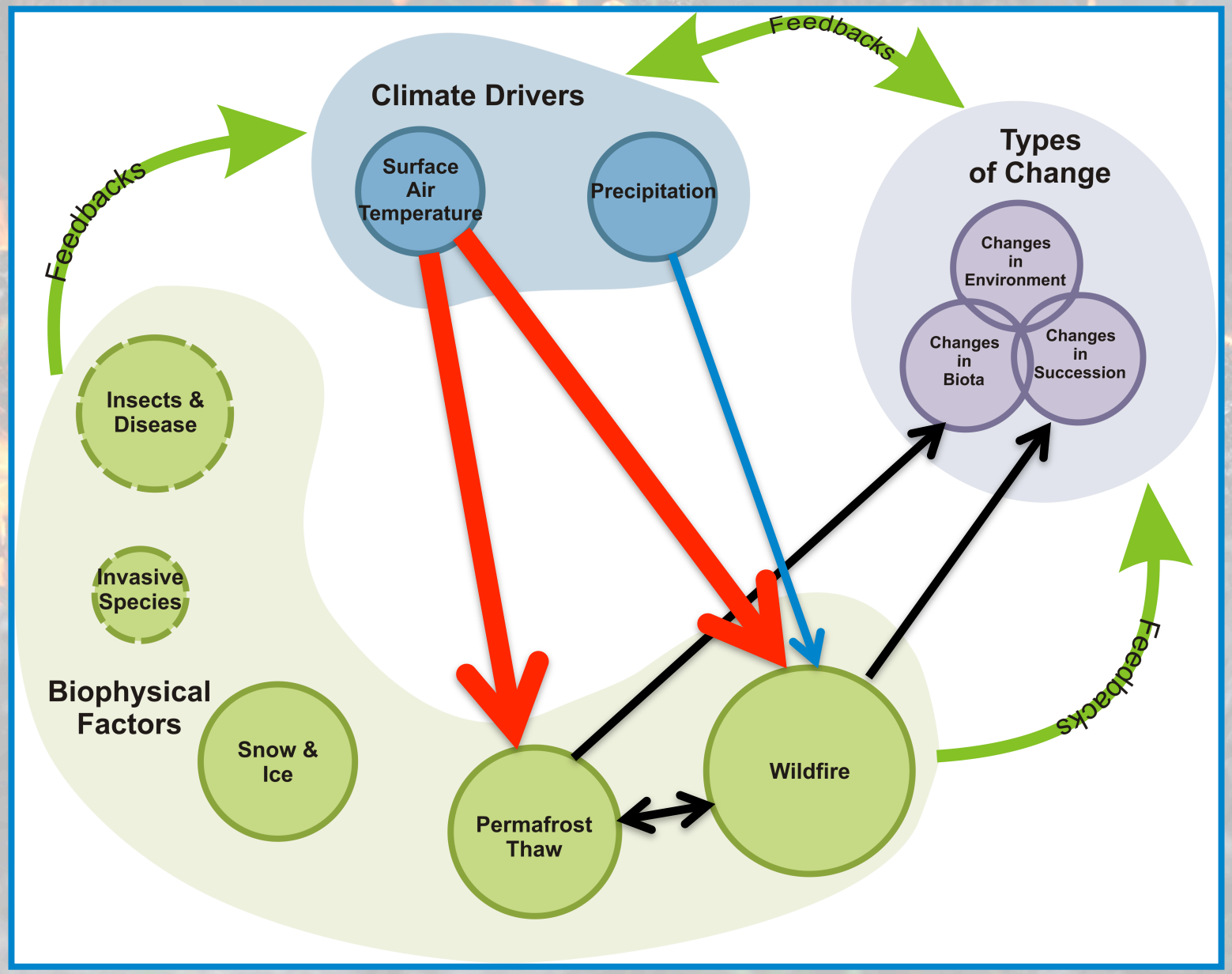
Types of Change
= the categories of change that occur in all forests (e.g., changes in environment, succession, and biota)

The Process…

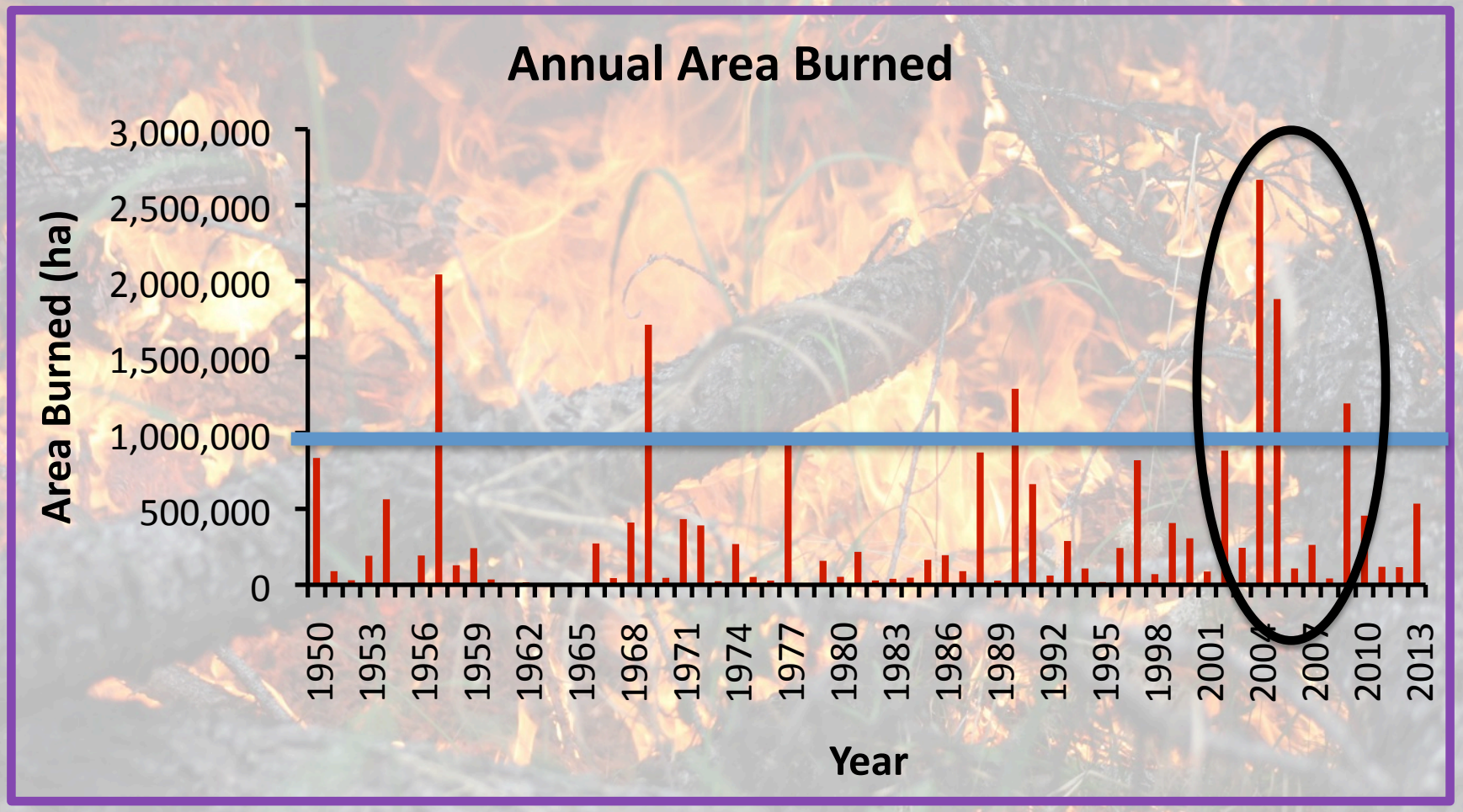

Regions of Interest
Permafrost
Wildfire
Interior boreal
Insects
Invasives
Permafrost
Wildfire
Insects
Invasives
Southcentral boreal
Kenai boreal
Coastal temperate
Snow
Ice
N
0
250
500
Kilometers


How is climate change impacting fire in Alaska's boreal forests?

Interior-Boreal



Interior-boreal: Annual Area Burned



Interior-Boreal: Wildfire

Changes in Succession

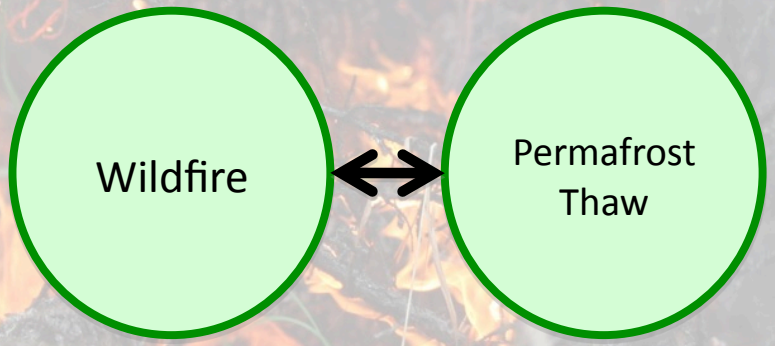
- Historically, black spruce forests burned during stand replacing fires every 70-130 yrs
  - Low severity wildfires in combination with black spruce traits and understory species led to a resilient forest type
- Post-fire succession has shifted towards deciduous dominated forests
  - Fires burn late into the summer
  - The deeper depth of burn creates a radically different environment for seedling establishment

Changes in Biota

- Changes in forest composition will increase moose habitat in the short term
- Wildlife species which prefer distinct forest types are predicted to decrease (e.g., red squirrels and caribou)

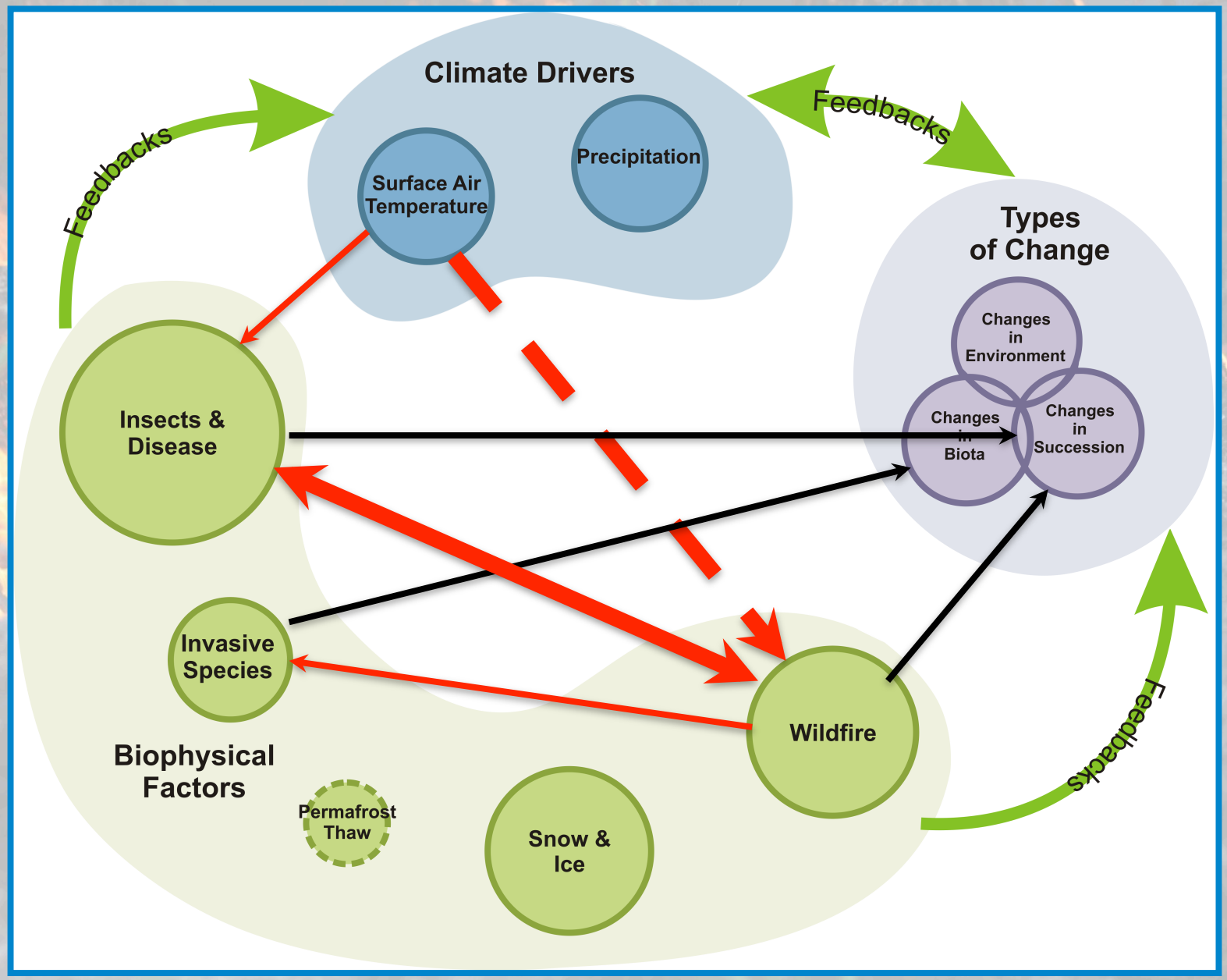
Interior-Boreal: Permafrost-Wildfire Interactions

- Following fire, permafrost degradation/aggradation is determined by the thickness of the SOL, and moss species
- Projected warming and an increase in wildfire will increase permafrost thaw post-fire




http://www.iarc.uaf.edu/highlights/2009/effects_fire_permafrost/fig1.jpg

Southcentral- and Kenai-Boreal



Southcentral/Kenai-Boreal: Insects

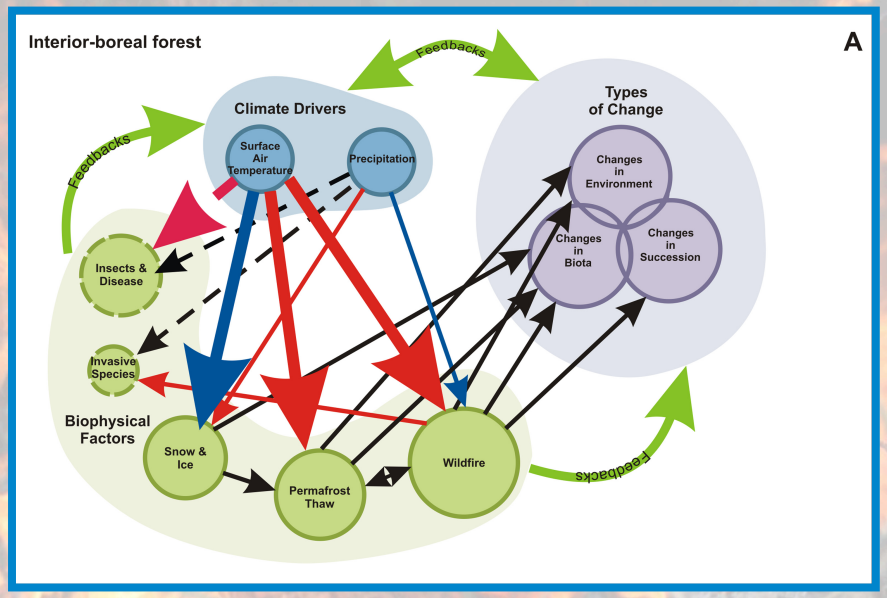
Changes in Succession

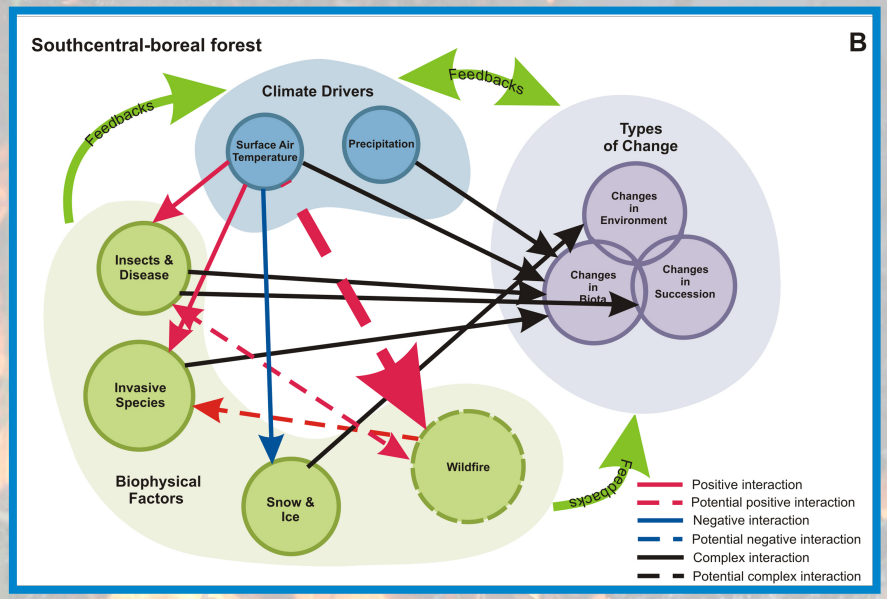
- Increasing temperatures decreased the life cycle of spruce bark beetles from 2 years to 1 year
- High spruce mortality
  - Led to very high fuel loads
  - Increased the potential for larger, high severity wildfires

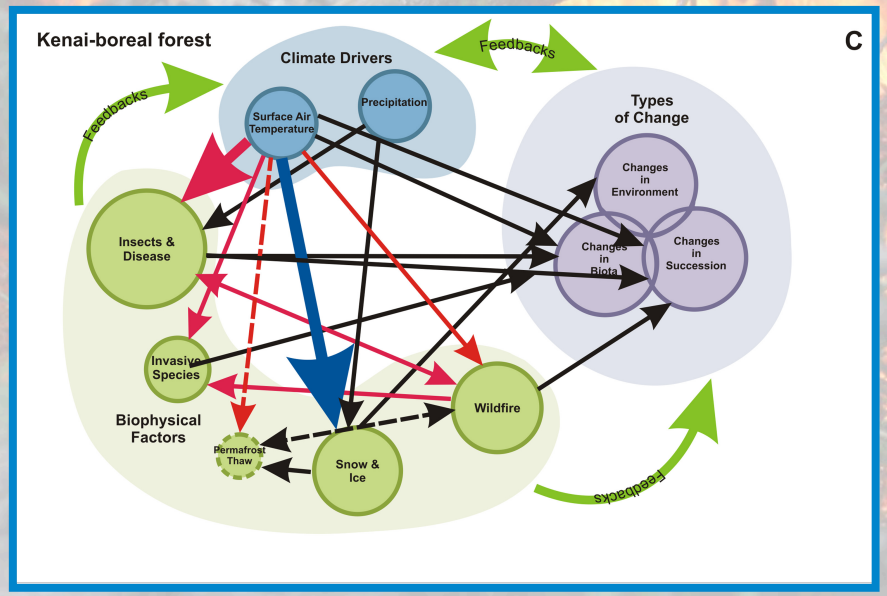
Changes in Biota

- Invasive plant species may increase with the confluence of increasing human population, wildfire potential and the increased likelihood of invasive plants establishing in recently burned areas

Comparison of Alaska's Boreal Forest Regions







SUMMARY

- The conceptual framework provides a **visual tool** for resource managers and policy makers
  - Increase understanding of complex interactions
  - Identify gaps in our knowledge
- Climate changes have important **regional consequences for Alaska residents**
- Climate changes also impact the **global climate system** via effects on carbon and radiation budgets

Summary: Interior-Boreal

- Has the richest research history
- Projections indicate that **wildfire and its interactions with permafrost** degradation will become increasingly important

Summary: Southcentral-Boreal

- We can expect an increase in the frequency and severity of insect outbreaks and associated wildfires
- An increase in invasive plant species establishment is also expected, especially in burned areas

Summary: Kenai-Boreal

- Kenai-boreal = **CANARY IN THE COAL MINE**
- All of the *biophysical factors* described in our regional conceptual frameworks are altering the structure and function of forests
- Future climate changes will likely be amplified by the confluence of population growth in this region
- We hypothesize that this is the region where **the greatest ecological changes will occur in a relatively short period of time**

CASE STUDY: Alaskan Boreal Forest

- Boreal forests in Alaska play an important role in global carbon budgets
- Commercial forestry in Alaska's forests is small-scale relative to other areas
- Alaska may serve as a **BASELINE** from which to measure our ability to practice natural disturbance-based forest management in other areas

Acknowledgements

- **Coauthors:** T.N. Hollingsworth, T.S. Rupp, S.F. Trainor, T.M. Barrett, E.A. Beever, F.S. Chapin, III., J.S. Conn, L.K. Crone, D.V. D'Amore, E.S. Euskirchen, N. Fresco, T.A. Hanley, P.E. Hennon, K. Kielland, J.J. Kruse, A.D. McGuire, T. Patterson, E.A.G. Schuur, P.F. Sullivan, D.L. Verbyla, and J. Yarie

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